

Photogrammetry and Mapping



Photogrammetry

Photogrammetry is generally defined as the art and science of making accurate measurements from vertical aerial photography.

Introduction

- Equipment
- Processes
- Products
- Applications
- Accuracy

Equipment

■ HP xw8400 Softcopy Workstation



Photogrammetric Processes

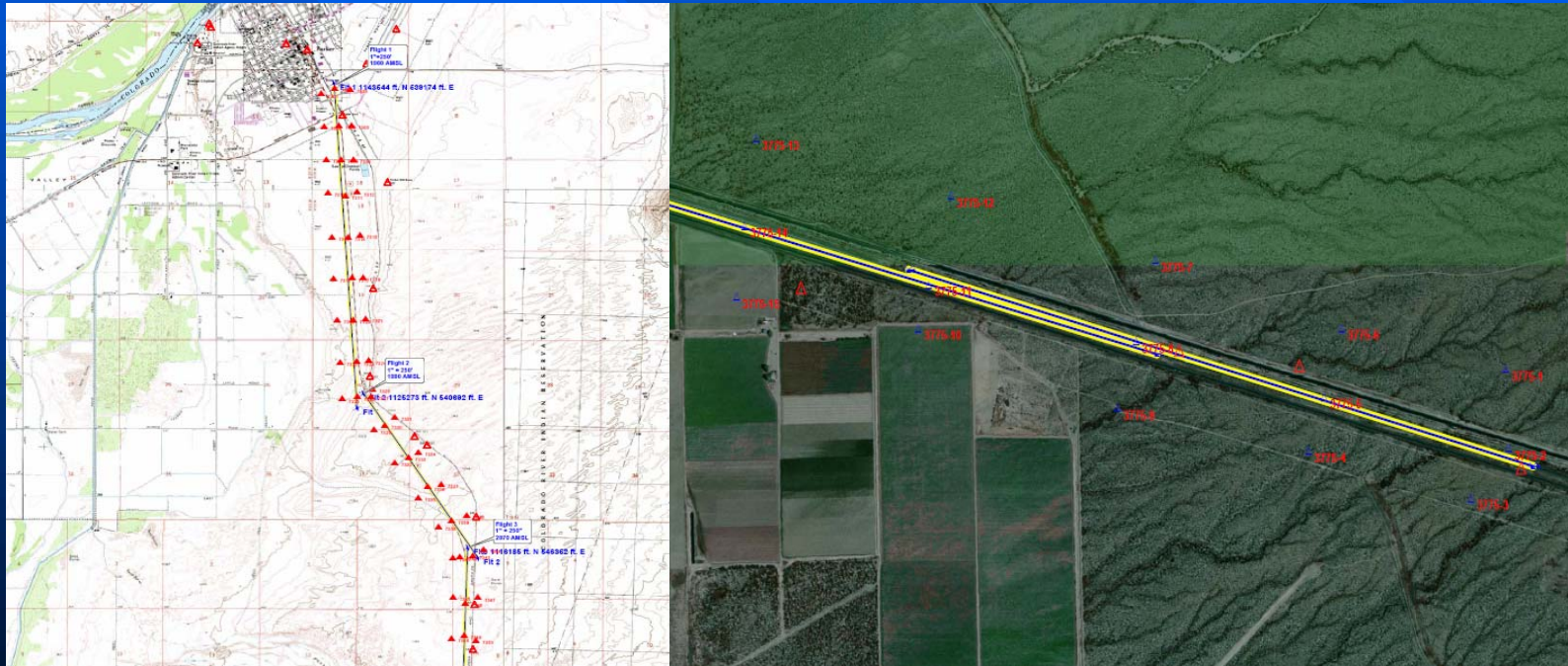
Photogrammetric mapping is achieved through five general processes:

- Ground Control Acquisition
- Imagery Acquisition
- Accurate Adjustment of the Imagery to the Earth
- Feature Collection
- Editing

Photogrammetric Processes

■ Ground Control Acquisition

- Established by Mission Planning / Practical Considerations



Practical Considerations

■ Mission Planning

- Purpose of the Project (Hydrology, Pre-design, Earthwork, etc.)
- Identification of the Project Area (Mapping Limits)
- Previous Mapping of the Project Area or Surrounding Area
- Legal Permits of Project Area Needed
- Required Contour Interval
- Proposed Photo Scale / Mapping Scale
- Weather

Practical Considerations (continued)

- Availability of the Aircraft
- Current Workload / Production Schedules
- Project Manager's Deadline
- Time of Year (Photographic Considerations)
- Survey Team Schedules
- Estimated Cost to Complete Project
- Coordinate Reference Systems
 - » Horizontal Datum
 - » Vertical Datum
 - » State Plane Coordinate System

Coordinate Reference Systems

■ State Plane Coordinate System (UTM Projection)

- Three Zones in Arizona:

- » West Zone
- » Central Zone
- » East Zone

■ Reference Datums

- NAD 27 (Horizontal)
- NAD 83/92 (Horizontal)
- NGVD29 (Vertical)
- NAVD 88 (Vertical)
- WGS84 (World Geodetic System)
- HARNs (High Accuracy Reference Networks)

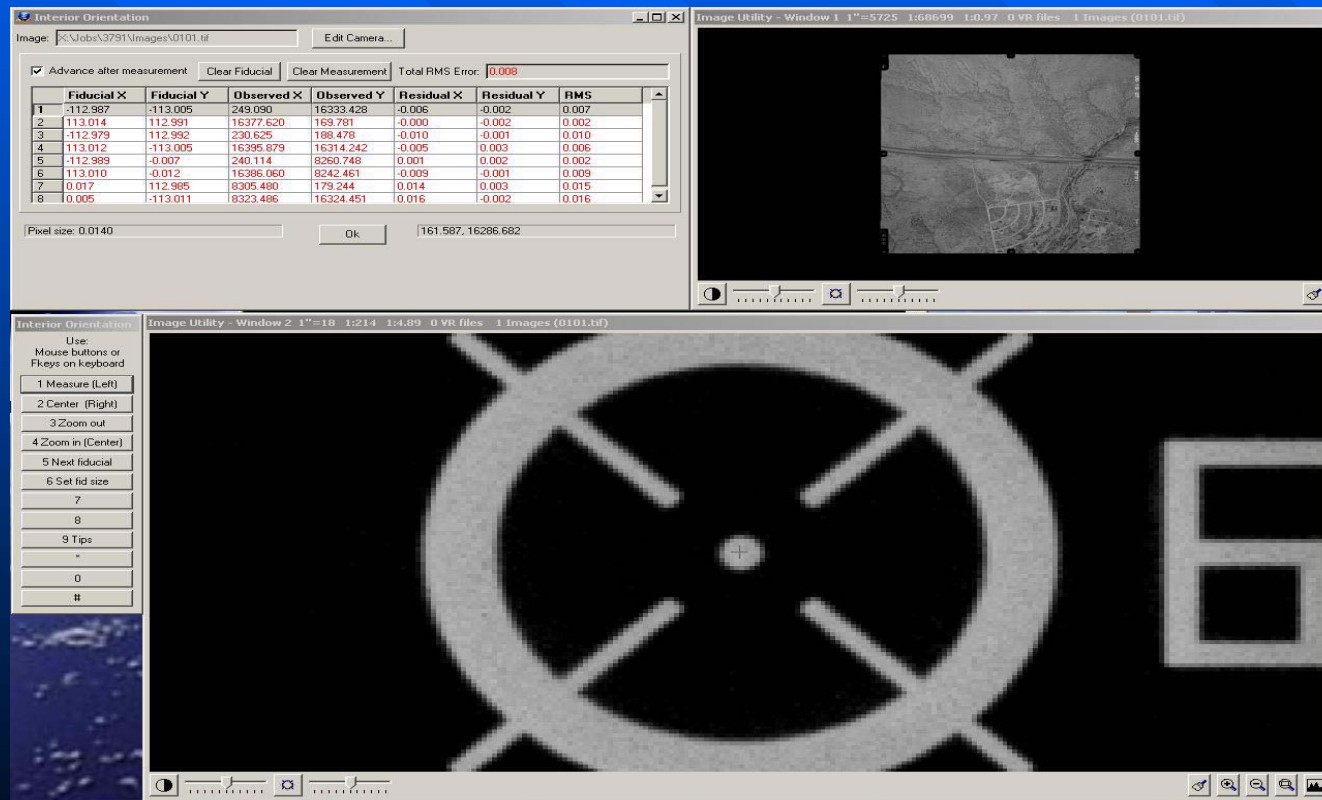


Photogrammetric Processes

- Accurate Adjustment of the Imagery to the Earth
 - Aerotriangulation Process
 - » Interior Orientation
 - » Relative Orientation
 - » Absolute Orientation
 - » Evaluation/Analysis of AT Results

Photogrammetric Processes

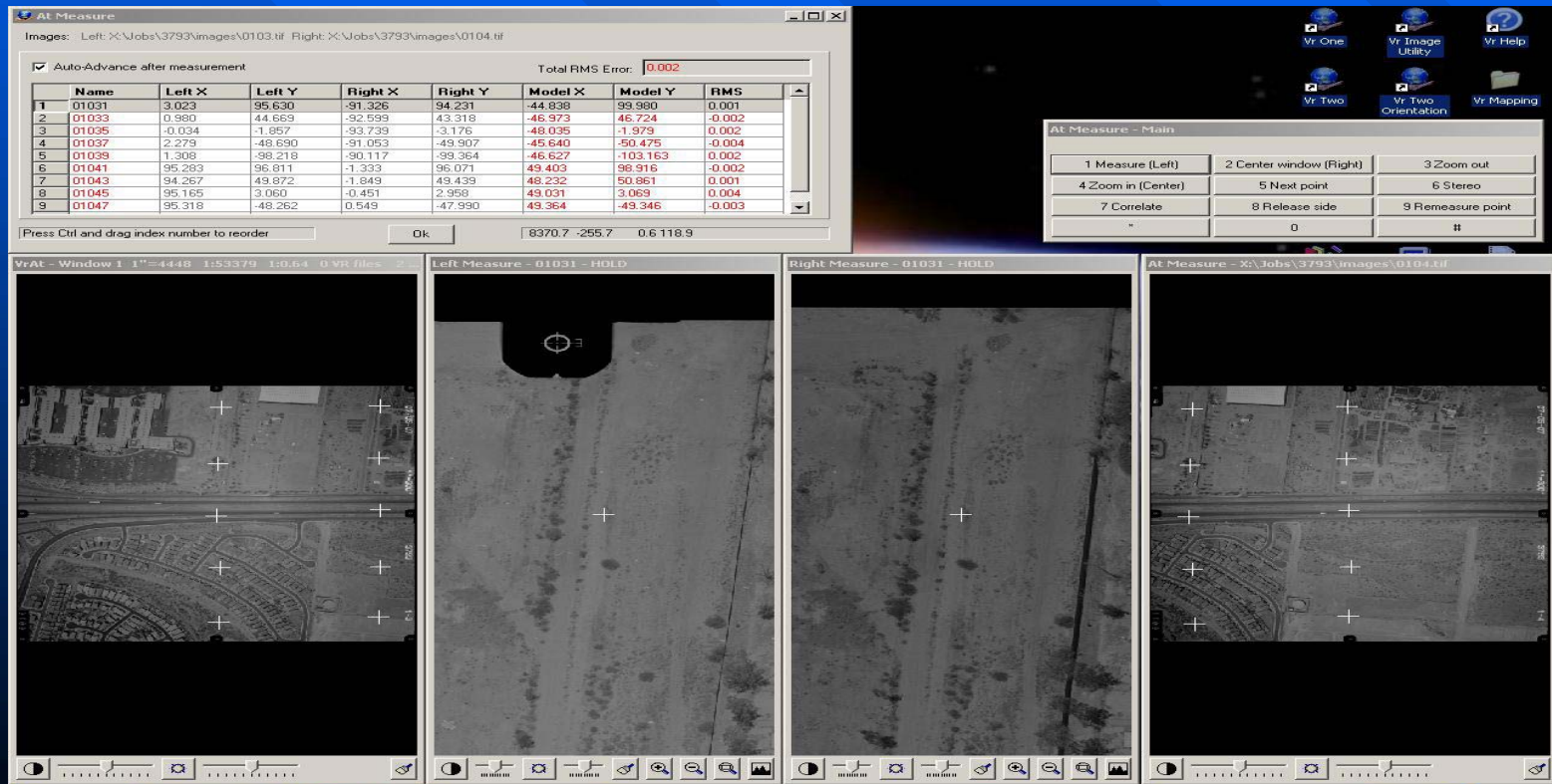
- Interior Orientation
 - Image Fiducial Coordinates Measured



Photogrammetric Processes

■ Relative Orientation

- Ground Control and Pass Points Measured (Controls the Stereo Model)



Photogrammetric Processes

■ Absolute Orientation

– Adjusts the Stereo Models (Imagery) to Fit the Ground

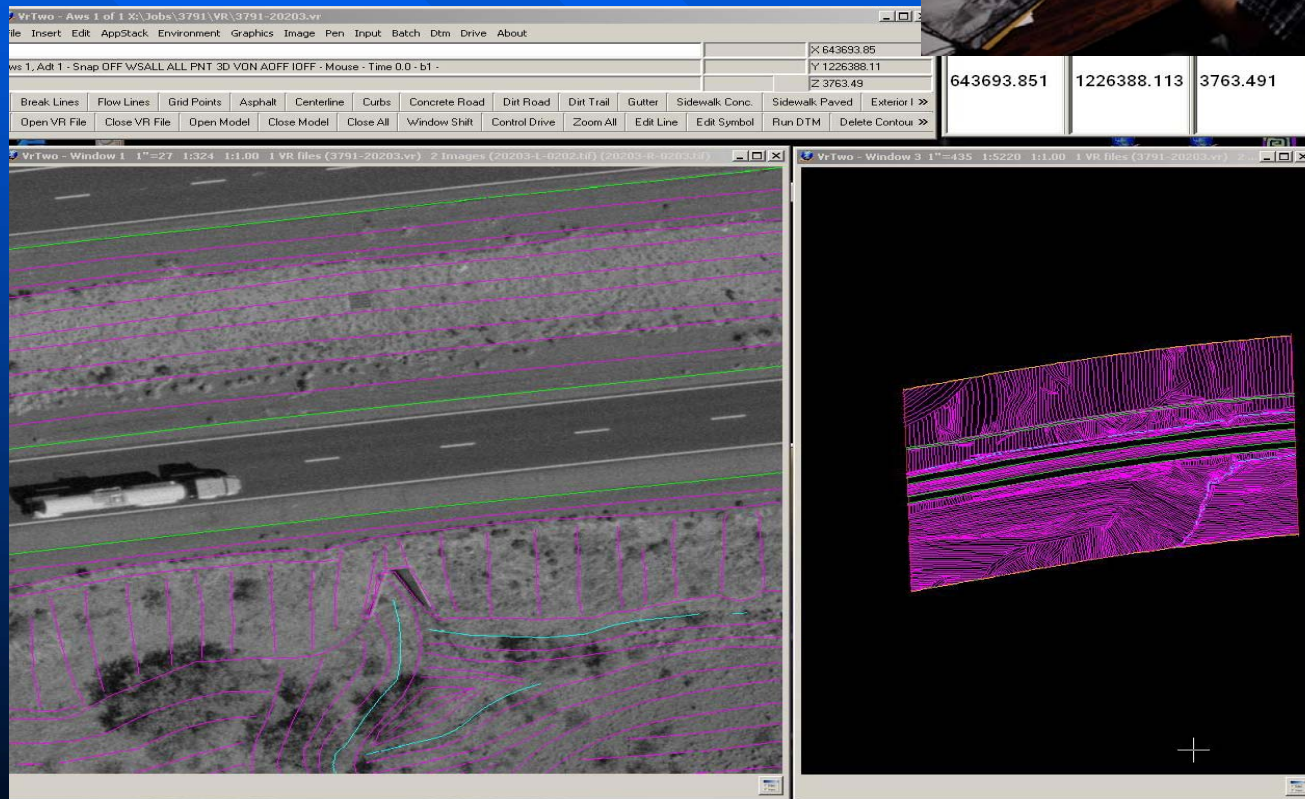
The screenshot displays the VrAerial Triangulation (VrAT) software interface. The main window shows a stereo image pair of a residential area with various points labeled (e.g., 01Q31, 01Q41, 01Q33, 01Q43, 01Q35, 01Q45, 01Q37, 01Q47, 01Q39, 01Q49). The interface includes a menu bar (File, Camera, Coordinates, Project, Layout, Export, About) and a toolbar. The status bar at the bottom indicates the current project and image files.

On the right, a Notepad window displays the output file VrAerosys.rep, which contains a list of adjusted coordinates for various points. The data is organized into columns for Point, X, Y, and Z coordinates.

Point	X	Y	Z
3789-43	629341.623	1046218.227	1902.115
3789-44	630327.231	1045883.034	1904.980
3789-45	631295.079	1045777.875	1886.927
3789-46	631091.591	1048812.697	1944.046
3789-47	630051.338	1048837.297	1942.658
3789-48	629054.371	1048743.417	1931.562
3793-11	630869.204	1061031.913	2073.772
3793-13	629922.610	1063557.508	2103.412

Photogrammetric Processes

- Feature or DTM Collection
 - VR Two Softcopy Operation



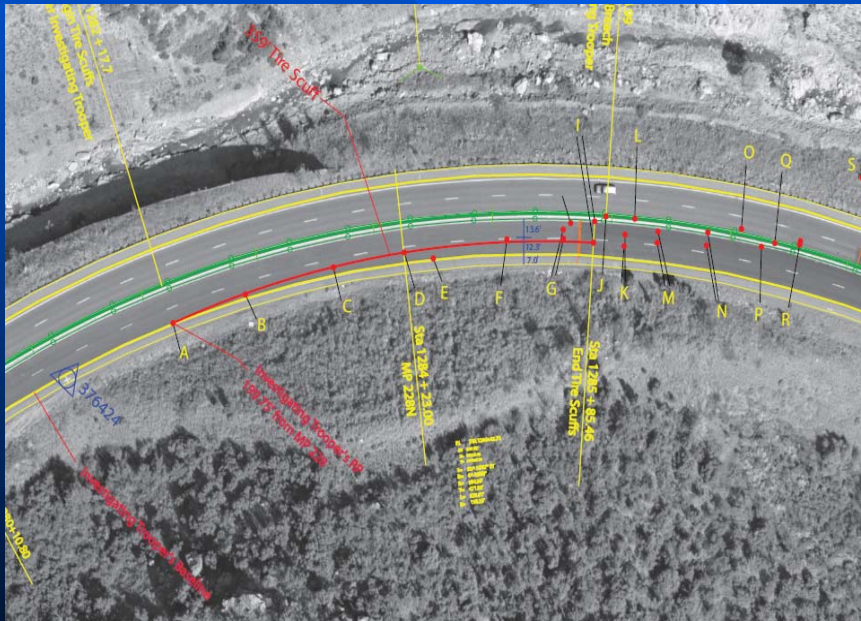
Photogrammetric Processes

- Editing of Final Mapping and Deliverable Items
 - Adding notes to structures
 - Checking spot elevations
 - Adding title blocks/Index for the final maps
 - Cutting the final sheets
 - Preparing the final CD including:DTM files; DGN Files; 3D Files; Survey Data (Excel Files) Including Ground Control, Structures, Mileposts, Section Corners, Utilities; Alignment; and Orthophotos

Products

■ Orthophotography

- Relief displacement removed
- Single orthorectified image
- Multiple orthorectified images (mosaics)



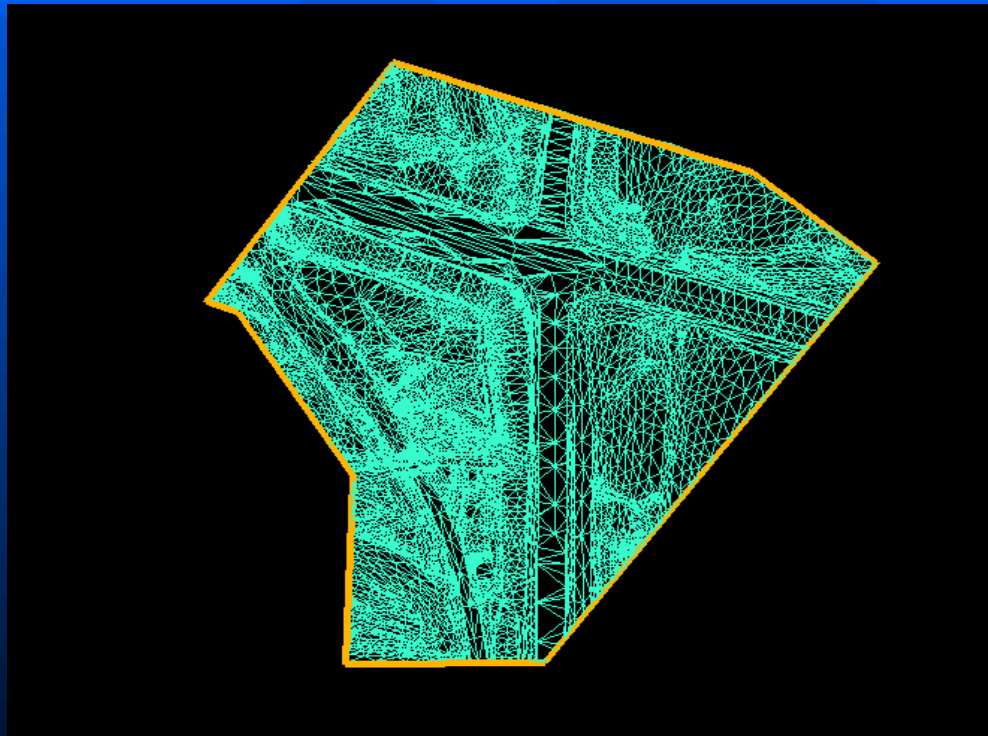
Products

- Digital Mapping
 - Digital Terrain Models (3D Data)



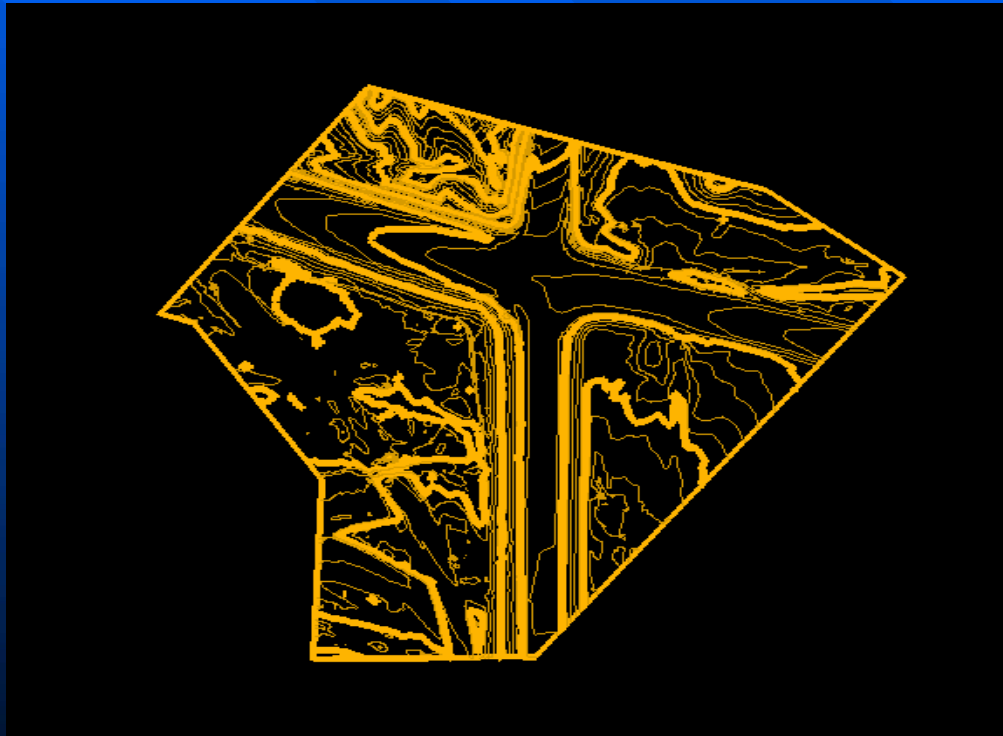
Products

- Digital Mapping
 - Digital Terrain Models (Triangulated Surface)



Products

- Digital Mapping
 - Contour Generation



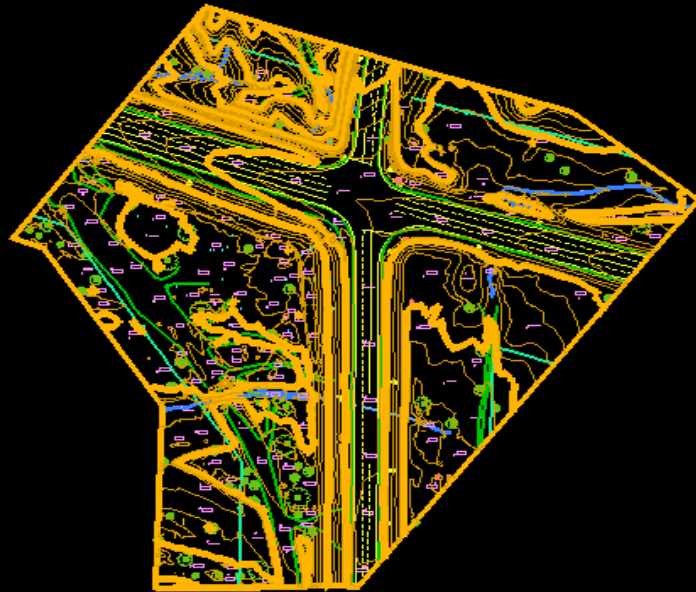
Products

- Digital Mapping
 - Planimetric



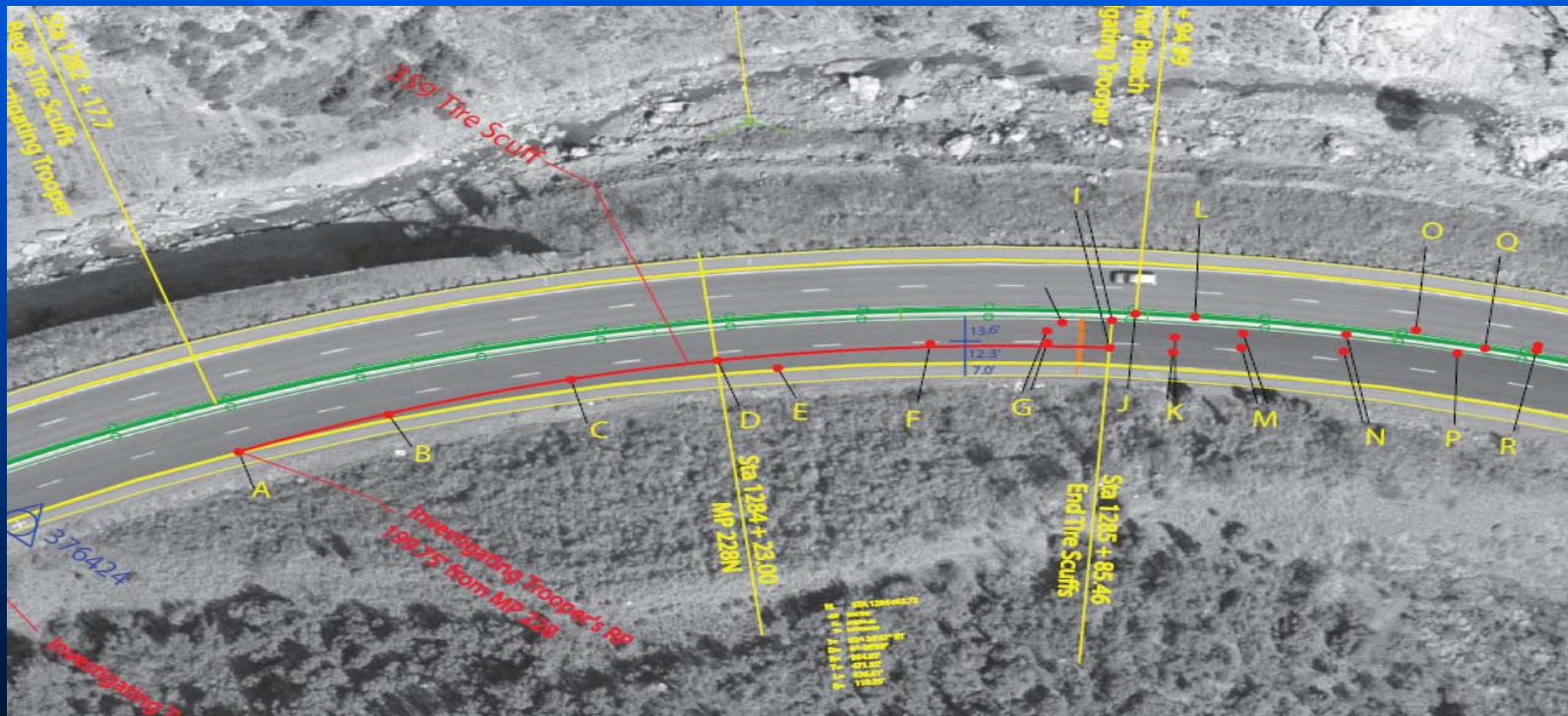
Products

- Digital Mapping
 - Topographic Mapping



Products

■ Superimposed Digital Data/Mapping Over Orthophotography



Photogrammetry and Mapping Applications

- Photogrammetric products used for:
 - Public Hearings / Legal Displays / Accident Investigation
 - Environmental Studies
 - 404 Permits
 - Landscape Design
 - Airport Land-use Updates
 - Hydrology Studies / Erosion Prevention / Flood Control Studies
 - Earthwork Calculations
 - Material Pit Inventories
 - Preliminary Design Work
 - Historical Studies
 - GIS Base Maps

Accuracy Standards

■ Horizontal Accuracy

- At least 90% of all well-defined planimetric features shall be within 0.025 inch of their true position, and 100% shall be within 0.05 inch of their true position.

■ Vertical Accuracy

- At least 90% of all contours shall be within $\frac{1}{2}$ contour interval of true elevation, and all contours shall be within one contour interval of true elevation (with some exceptions of obscured/shadow areas).
- At least 90% of all spot elevations shall be within 0.25 contour interval of true elevation and 100% shall be within 0.50 contour interval of true elevation.

Accuracy Standards

■ Case Study

- Quartzsite Parker Topock Highway – SR95
- Mile Post 131.7 to 142.7
- Job Number 3773
- Control Obtained by RTK GPS
- NAD83/92 Horizontal
- NAVD88 Vertical
- GAF = 1.00008
- State Plane = Western Zone

Accuracy Standards

■ Photogrammetric Accuracy

- National Map Accuracy Standards = 0.5 (ft) vertical for 1"=50' mapping with 1 foot contour interval.
- Photogrammetric vertical measurement maximum ground residuals for this project was 0.143 (ft).
- Photogrammetric mean standard deviation of objects was 0.091 (ft).